DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabus

For

M.Sc (Hons.)-CHEMISTRY

(Program ID-39)

1^{st} TO 4^{th} SEMESTER

2018-2019

Total minimum credits required for M.Sc. (Hons.) Chemistry are 96

Scheme of Courses M.Sc.

M.Sc. (Hons.) Chemistry

Semester 1

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE501B	Core	Organic Chemistry-I	4	0	0	4
2	CHE502B	Core	Inorganic Chemistry-I	4	0	0	4
3	CHE503B	Core	Physical Chemistry	4	0	0	4
4	CHE504B	Core	Analytical Chemistry	4	0	0	4
5	CHE505B	Core	Organic Chemistry Lab-I	0	0	4	2
6	CHE506B	Core	Inorganic Chemistry Lab-I	0	0	4	2
7	Interdisciplinary Course-I						4
Total							24

Semester 2

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE507B	Core	Organic Chemistry-II	4	0	0	4
2	CHE508B	Core	Inorganic Chemistry-II	4	0	0	4
3	CHE509B	Core	Physical Chemistry-II	4	0	0	4
4	CHE510B	Core	Spectroscopy-I	4	0	0	4
5	CHE511B	Core	Organic Chemistry Lab-II	0	0	4	2
6	CHE512B	Core	Physical Chemistry Lab-I	0	0	4	2
7	Interdisciplinary Course-II						4
Total							24

Semester 3

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE601B	Core	Organic Chemistry-III	4	0	0	4
2	CHE602B	Core	Inorganic Chemistry-III	4	0	0	4
3	CHE603B	Core	Physical Chemistry-III	4	0	0	4
4	CHE604B	Core	Spectroscopy-II	4	0	0	4
5	CHE606B	Core	Inorganic Chemistry Lab-II	0	0	4	2
6	CHE607B	Core	Physical Chemistry Lab-II	0	0	4	2
7	CHE608B*	Core	Seminar and Literature Survey	0	0	0	2*
8	CHE620B*	Core	Advance Chemistry Lab-I	0	0	8	4*
	Department Elective-I						4
	Total						26/28*
Department Elective-I							
1	CHE605B	Elective	Advanced Electrochemistry	4	0	0	4
2	CHE617B	Elective	Synthetic Organic Chemistry	4	0	0	4
3	CHE614B	Elective	Molecules of Life	4	0	0	4
4	PHY670	Elective	Nanoscience and Nanotechnology	4	0	0	4

***Only 30 students in the class will be enrolled for research projects based upon their merit/performance in MSc first year. The students with research projects will study CHE608B of 2 credits and the others will study CHE620B of 4 credits in the third semester.**

Semester 4

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE609B	Core	Organic Chemistry-IV	4	0	0	4
2	CHE610B	Core	Bio-Inorganic Chemistry	4	0	0	4
3	CHE612B*	Core	Project	0	0	0	6*
4	CHE621B*	Core	Advance Chemistry Lab-II	0	0	8	4*
5	Departmental Elective			4	0	0	4
6	Departmental Elective			4	0	0	4
	Total						20*/22*
Departmental Elective (Choose any Two courses)							
1	CHE611B	Elective	Bio-Physical Chemistry	4	0	0	4
2	CHE613B	Elective	Supramolecular Chemistry	4	0	0	4
3	CHE615B	Elective	Chemistry of Materials	4	0	0	4
4	CHE616B	Elective	Medicinal Chemistry	4	0	0	4

5	**CHE618B**	**Elective**	**Advance Physical Chemistry**	**4**	**0**	**0**	**4**
6	**CHE619B**	**Elective**	**Analytical Techniques**	**4**	**0**	**0**	**4**

***The students with research projects will do Project work (CHE612B) of 6 credits and the others will study Advance chemistry Lab-II (CHE621B) of 4 credits in the fourth semester.**

Scheme of Courses M.Sc.

M.Sc. (Hons.) Chemistry

Semester 1

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE501B	Core	Organic Chemistry-I	4	0	0	4
2	CHE502B	Core	Inorganic Chemistry-I	4	0	0	4
3	CHE503B	Core	Physical Chemistry	4	0	0	4
4	CHE504B	Core	Analytical Chemistry	4	0	0	4
5	CHE505B	Core	Organic Chemistry Lab-I	0	0	4	2
6	CHE506B	Core	Inorganic Chemistry Lab-I	0	0	4	2
7	Interdisciplinary Course-I						4
Total							24

L: Lectures T: Tutorial P: Practical Cr: Credits

Course Title: Organic Chemistry-I

Course Code: CHE501B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Nature of Bonding in Organic molecules **(06 Letures)**

Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, tautomerism.

Aromaticity: Concept of aromaticity, Huckel's rule, Polygon rule, Homo-aromatic, non-aromatic and anti-aromatic systems. Aromaticity in benzenoid and non-benzenoid molecules.alternant and non-alternant hydrocarbonsAnnulenes& hetero-annulenes. Physical methods to study aromaticity-UV, IR &1H NMR.

Reaction Mechanism: Structure and Reactivity **(10 Letures)**

Type of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams. Methods of Determining Reaction Mechanism: Kinetic and non-kinetic methods, Identification of products, detection of intermediates, isotopic labeling, stereochemical evidences, cross-over experiments, Limitation of reactions, kinetic evidences and kinetic isotopic effects.

Reaction Intermediates:Generation, structure, stability, reactivity, detection, trapping and reactions of classical and non-classical carbocations, carbanions, free radicals, carbenes, nitrenes and arynes.

UNIT II

Aliphatic Nucleophilic Substitution (8 Letures)

Aliphatic Nucleophilic Substitution Reactions: Mechanism and scope of aliphatic nucleophilic substitution reactions-SN1, SN2 and SNi. Stereochemistry of nucleophilic substitution reactions, allylic nucleophilic substitution reactions, Walden inversion, neighbouring group participation &anchimeric assistance, carbocation rearrangements in neighboring group participation. Factors influencing the rates of nucleophilic substitution reactions.

Aliphatic Electrophilic Substitution (10 Letures)

Bio-molecular mechanisms-SE2 and SEi. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Elimination Reactions:Discussions of E1, E2 and E1cB mechanisms. Orientation during elimination reactions. Saytzeff and Hofmann rules. Reactivity-effects of substrate structures, attacking base, leaving group and solvent medium.

Pyrolytic Eliminations: Mechanisms of pyrolysis of esters of carboxylic acids. Chugaev reactions, Hofmann degradation, Cope elimination and xanthate pyrolysis.

UNIT III

Aromatic Electrophilic Substitution (8 Letures)

Mechanism of aromatic electrophilic substitution reactions - nitration, halogenation, sulphonation, Friedel-Crafts alkylation and acylation, orientation and reactivity, energy profile diagram. The ortho/para ratio, ipso attack, orientation in other ring systems., Naphthalene, Anthracene, Six and five membered heterocycles, Diazonium couplingMechanism of Vilsmeir-Haack reaction, Mannich reaction, Diazonium coupling, Pechmann reaction and Fries rearrangement, Gattermann – Koch reaction,.

Aromatic Nucleophilic Substitution (4 Letures)

The SNAr, SN1 Benzyne and SNR1, Mechanisms, Reactivity effect of substrate structure, leaving group and attacking nucleophile.

UNIT IV

Stereochemistry **(14 Letures)**

Optical Isomerism: Conformation and configuration of molecules, projection formulae, Fischer, Saw-horse, Newman and Flying wedge representations.Interconversion of these formulae. Absolute configuration (D,L) and (R,S) systems. Elements of symmetry, Pseudoassymmetric centres, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, stereospecific and stereoselective synthesis, asymmetric synthesis, Cram's and Prelog's rules. Optical activity in the absence of chiral carbon-biphenyls, allenes and spiranes. Conformational analysis of cycloalkanes and decalins. Effect of conformation on reactivity. Acyclic & cyclic systems-Substituted cyclohexanes, cyclohexanones, cyclohexanols, Stereochemistry of compounds containing nitrogen, sulphur and phosphorus.

Geometrical Isomerism: Cis-trans isomerism resulting from double bonds, monocyclic compounds & fused ring systems. E,Z-notations, determination of configuration of geometricalisomers, syn& anti isomers.

Suggested Books:

1. March, Jerry. *Advanced Organic Chemistry: Reactions, Mechanism and Structure*, John Wiley, 7th edition, 2013.
2. Carey, F. A. and Sundberg, R.J. *Advanced Organic Chemistry*, Plenum, 5th edition, 2008.
3. Sykes, Peter. *A Guide Book to mechanism in Organic Chemistry*, Longman, 6th edition, 1989.
4. Morrison, R. T. and Boyd, R. N. *Organic Chemistry*, Prentice Hall, 6th edition, 1992.
5. Kalsi, P. S. *Organic Reactions and their Mechanisms*, New Age International Publishers, 2nd edition, 2000.
6. Mukherji, S.M. and Singh, S.P. *Reactions Mechanism in Chemistry*, Vol. I, II, III, Macmillan, 1985.
7. Nasipuri, D. *Stereochemistry of Organic Compounds*, New Age International Publishers, 2nd edition, 1994.
8. Kalsi, P.S. *Stereochemistry of Organic Compounds*, New Age International, 2nd edition, 1993.
9. Kalsi, P.S. *Stereochemistry: Conformation and Mechanism*, Wiley Eastern Limited, 2nd edition, 1993.

Course Title: Inorganic Chemistry –I (Transition Metal Chemistry)

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Code: CHE502B

Total Lectures: 60

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in the course.

UNIT I

Symmetry **(18 Lectures**)

Symmetry elements, symmetry operations and their matrix representation, group postulates and types, multiplication tables, point group determination, determination of reducible and irreducible representations, character tables, construction of character tables for C_{2v}, C_{3v}, use of symmetry in obtaining symmetry of orbitals in molecules, Determination of hybridization, vibrational modes and selection rules for electronic transitions in molecules using Character table

Molecular Orbital Theory for Metal Complexes

Ligands symmetry orbitals and metal orbitals involved in molecular orbitals formation in octahedral complexes, MOEL diagrams for octahedral, tetrahedral and square planar complexes showing σ and π bonding in transition metal complexes.

UNIT II

Inter-electronic Repulsions **(15 Lectures)**

Spin-spin, orbital-orbital and spin orbital coupling, LS and jj coupling schemes, determination of all the spectroscopic terms of p^n, d^n ions, determination of the ground state terms for p^n, d^n, f^n ions using L.S. scheme, determination of total degeneracy of terms, order of interelectronic repulsions and crystal field strength in various fields, two type of electron repulsion parameters, spin orbit coupling parameters (λ) energy separation between different j states, The effect of octahedral and tetrahedral fields on S, P, D and F terms (with the help of character table). Splitting patterns of G, H and I terms

UNIT III

Free Ions in Medium and Strong Crystal Fields (12 Lectures)

Strong field configurations, transition from weak to strong crystal fields, evaluation of strong crystal field terms of d^2 configuration in octahedral and tetrahedral crystal fields (using group theory), construction of the correlation energy level diagrams of d^2 configuration in octahedral field, study of energy level diagrams for higher configurations, Orgel diagrams, Tanabe Sugano diagrams, calculation of 10Dq and B with use of Orgel and Tanabe Sugano diagrams.

UNIT IV

Electronic Spectra of Transition Metal Complexes (15 Lectures)

Variation of the Racah parameter, nephlauxetic effect-central field covalency, symmetry restricted covalency, differential radial expansion, spectrochemical series, band intensities, factors influencing band widths, Magnetic properties of transition metal ions and free ions presentive, Effects of L-S coupling on magnetic properties, Temperature independent paramagnetism (TIP) in terms of crystal field theory CFT and molecular orbital theory (MOT), Quenching of orbital angular momentum by crystal fields in complexes in terms of term-splitting. Effect of spin-orbit coupling and A, E & T states mixing, first order and second order Zeeman effects.

Suggested Books:

1. Cotton, F.A. Chemical Application of Group Theory, Wiley Eastern, 4th edition.
2. Miessler, G.L. and Tarr, D.A. Inorganic Chemistry, Pearson Education, 3rd edition.
3. Figgis, B.N. Introduction to Ligand Field, WileyEastern.

4. Lever, A.B.P. Inorganic Electronic Spectroscopy, Elsevier.

5. Huheey, J.E. Inorganic Chemistry Principles of Structure and Reactivity, Harper Interscience.

6. Drago, R.S. Physical Method in Chemistry, W.B. Saunders Company.

7. Cotton F.A. and Wilkinson, G. Advanced Inorganic Chemistry, Wiley Inter-science, 6^{th} edition.

Course Title: Physical Chemistry I

Course Code: CHE503B

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Total Lectures: 60

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post graduation in the course.

UNIT I

Partial Molar Properties **(20 Lectures)**

Recapitulation of thermodynamic laws, Partial molar quantities, chemical potential and Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential of ideal gas mixture (s), determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential.

Real Gases: Concept of Fugacity and Activity

Concept of fugacity, methods for determining the fugacity of a real gas and its variation with temperature and pressure, activity, choice of standard states, dependence of activity on temperature and pressure, determination of activity by (i) measurement of vapour pressure, (ii) distribution of solute between two immiscible solvents and (iii) e.m.f measurement.

UNIT II

Solution & Phase Equilibrium **(15 Lectures)**

Solubility and factors affecting solubility, types of solutions, ideal solution, vapour pressure of ideal solutions, boiling point diagrams of binary miscible mixtures and their Distillation diagrams, azeotropes, critical solution temperatures, solubility of gases in liquids, Henry's law, Nernst distribution law, number of extractions, solutions of solids in liquids & chemical equilibrium. Derivation of Gibb's phase rule, phase equilibria of two component systems showing eutectic congruent and incongruent melting points.

UNIT III

Statistical Thermodynamics **(15 Lectures)**

F.D. statistics, distribution law, Bose Einstein's statistics. (using Lagrange's method of undetermined multipliers).

Partition functions: Translational, Rotational, Vibrational, Electronic partitions functions. Calculation of Thermodynamic properties in terms of partition functions, Heat capacity, behavior of equilibrium constant in terms of partition function,

UNIT IV

Non Equilibrium Thermodynamics **(10 Lectures)**

Meaning and scope of irreversible thermodynamics. Thermodynamic criteria for non-equilibrium states, Phenomenological laws-linear laws, Gibb's equation, Onsager's reciprocal relation, Entropy production-specific laws of entropy production, Non-equilibrium stationary states, Prigogine's principle of entropy production, Coupled phemomena, Some important applications.

ESSENTIAL BOOKS:

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub.
2. Physical Chemistry, P.W. Atkins, Oxford University Press.
3. Thermodynamics for Chemists, S. Glasstone, Affiliated East-West Press.
4. Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin.
5. Physical Chemistry, P.W. Atkins, Oxford University Press, 11th Edition.

Course Title: Analytical Chemistry

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Code: CHE504B

Total Lectures: 60

Course Objectives:

This course is intended to learn the basic concepts of Analytical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective:

Thiscourse will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of analytical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in the course.

UNIT I

Elementary concepts (10 Lectures)

Qualitative and quantitative analysis, Concepts important to quantitative analysis, Classification of methods for quantitative analysis, Choice of method for analysis, Sampling, Preparation of samples for analysis, Calibration standards, Solution concentration in terms of various conventions, Simple equilibrium calculations, Calibration of analytical weights and glass wares, Significance of calibration.Evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors.

Electroanalytical Techniques (15 Lectures)

Electrogravimetry: Without potential control and controlled potential, applications. Coulometric methods and applications. Voltammetry and polarography: linear sweep Voltammetry, voltammetric electrodes, voltammograms, voltammograms for mixtures. Polarography: currents, dropping mercury electrodes, pulse polarography, cyclic Voltammetry, stripping methods, amperometric titrations.

UNIT II

X-ray diffraction methods of analysis **(10 Lectures)**

Production of X-rays, solid state symmetry, reciprocal lattice, Bragg's law in reciprocal space, the powder method, interpretation of powder pattern of a cubic system, particle size determination by powder method, qualitative and quantitative analysis using powder method. X-ray fluorescence spectroscopy, X-rays emission method, applications (qualitative and quantitative).

UNIT III

Thermo analytical or Thermometric Methods **(11 Lectures)**

Thermogravimetric analysis (TGA): Principle and method, automatic analysis, factors affecting results. Derivative Thermogravimetric analysis (DTG), applications. Differential thermal analysis (DTA): Principle and working, theory, simultaneous DTA-TGA curves, applications.

UNIT IV

Chromatography **(14 Lectures)**

Introduction, terminology and basic principle, Gas chromatography (GC): Instrumentation for Gas-Liquid chromatography, columns, stationary phases, applications, Gas-Solid chromatography. High-Performance Liquid Chromatography (HPLC), instrumentation, partition chromatography, Ion-Exchange chromatography, Size-Exclusion chromatography, Comparison of HPLC and GC.

Suggested Books

1. Christian G.D. *Analytical Chemistry,* John Wiley, 6th edition, 1994.

2. Skoog D.A., West, D.M., Holler, F.J. and Crouch, S.R. *Fundamentals of Analytical chemistry,* Brooks/Cole, 2004.

3. Skoog D.A. *Principles of Instrumental Analysis,* Holt-Saunders International edition, 3rd edition, 1985.

4. Bassett, J., Denney, R.C., Jeffery, G.H. and Mendham, J.*Vogel's Textbook of Quantitative Inorganic Analysis (revised),* Orient Longman, 4th edition, 1978.

5. Willard H.H., Merritt L.L. Jr, Dean J.A. and Settle F.A. Jr. *Instrumental Methods of Analysis,* California: Wadsworth Publishing Company, 7th edition, 1988.

Course Title: ORGANIC CHEMISTRY LAB I

Course Code: CHE505B

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic experimental concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in the course.

1. Organic Lab- (i) Safety: Eye, Fire and Chemicals (ii) Glassware (iii) Non-glass equipment (iv) Heating devices (v) Cleaning Glassware
2. To determine corrected melting points of an unknown organic compound (Calibration of thermometer).
3. Synthesis of Adipic acid from cyclohexanol (oxidation).
4. Synthesis of Aspirin from Salicylic acid.
5. Synthesis of benzyl alcohol and benzoic acid (Cannizzaro's reaction).
6. Synthesis of Dibenzal acetone from benzaldehyde (Claisen-Schmidt reaction).
7. Synthesis of Cinnamic acid from benzaldehyde (Knoevenaegal reaction).
8. Synthesis of Acetanilide and bromoacetanilide.
9. Synthesis of p-chlorotoluene from p-toludine
10. Synthesis of Benzanilide (Schotten-Baumann reaction).
11. Synthesis of o-Benzoylbenzoic acid (Friedel-Craft's reaction).

Suggested Books:

1. Harwood, L.M. and Moody, C.J. *Experimental Organic Chemistry*,Blackwell Scientific Publishers,1st edition, 1989.

2. Vogel, A.I. *Text Book of Practical Organic Chemistry*, ELBS,Longman Group Ltd.,5th edition,1978.

3. Mann, F.G. and Saunders, B.C. *Practical Organic Chemistry*,New Impression, Orient Longman Pvt. Ltd., 4th edition, 1975.

4. Leonard, J. and Lygo, B. *Advanced Practical Organic Chemistry*, Chapman and Hall, 1995.

Course Title: Inorganic Chemistry Lab –I

Course Code: CHE506B

Time: 04 Hrs

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry Laboratory. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various experiments have been designed to enhance laboratory skills of the postgraduate students.

Expected Prospective:

The students will be able to understand the basic objective of experiments in inorganic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. Theywill know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

I. Oxidation-Reduction Titrations

1. Standardization of $KMnO_4$with sodium oxalate and determination of Ca^{2+} ion.
2. Standardization of ceric sulphate with Mohr's salt and determination of Cu^{2+}, NO_2^- and $C_2O_4^{2-}$ ions.
3. Standardization of $K_2Cr_2O_7$ with Fe^{2+} and determination of Fe^{3+} (Ferric alum)
4. Standardization of hypo solution with potassium iodate / $K_2Cr_2O_7$ and determination of available Cl_2 in bleaching powder, Sb^{3+} and Cu^{2+}.
5. Determination of hydrazine with KIO_3 titration.

II. Precipitation Titrations

1. $AgNO_3$ standardization by Mohr's method.
2. Volhard's method for Cl^- determination.
3. Determination of ammonium / potassium thiocyanate.

III. Complexometric Titrations

1. Determination of Cu^{2+} and Ni^{2+} by using masking reagent by EDTA titration.
2. Determination of Ni^{2+} (back titration).
3. Determination of Ca^{2+} (by substitution method).

IV. Gravimetric Analysis

1. Determination of Ba^{2+} as its chromate.

2. Estimation of lead as its lead sulfate.

3. Estimation of Nickel (II) as its nickel dimethyl glyoximate.

4. Estimation of Cu^{2+}as cuprousthiocyanate.

Suggested Books:

1. Svehla,G. and Sivasankar,B.*Vogel's Qualitative Inorganic Analysis (revised)*,Pearson, 7th edition, 1996.

Scheme of Courses M.Sc.

M.Sc. (Hons.) Chemistry

Semester 2

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE507B	Core	Organic Chemistry-II	4	0	0	4
2	CHE508B	Core	Inorganic Chemistry-II	4	0	0	4
3	CHE509B	Core	Physical Chemistry-II	4	0	0	4
4	CHE510B	Core	Spectroscopy-I	4	0	0	4
5	CHE511B	Core	Organic Chemistry Lab-II	0	0	4	2
6	CHE512B	Core	Physical Chemistry Lab-I	0	0	4	2
7	Interdisciplinary Course-II						4
Total							24

L: Lectures T: Tutorial P: Practical Cr: Credits

Course Title: Organic Chemistry-II

Course Code: CHE507B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent resear
ch trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Addition to Carbon-Carbon Multiple Bonds (8 Lectures)

Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic ring. Hydroboration. Michael reaction, Sharpless asymmetric epoxidation.

Addition to Carbon-Heteroatom Multiple Bonds (12 Lectures)

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds acids, esters and nitriles. Addition of Grignard reagents, organozinc, organolithium, organocuprate reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction, Horner-Wadsworth-Emmons (HWE) reaction. Mechanism of condensation reactions involving enolates-Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

UNIT II

Oxidation Reactions (8 Lectures)

Introduction. Different oxidative processes. Oxidation of Hydrocarbons- alkenes, aromatic rings, aryl methanes, allylic oxidation of olefins. Oxidation of alcohols: Swern Oxidation, PCC, PDC oxidation, Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate, DDQ, CAN, selenium dioxide, peroxyacids, DCC. Baeyer-Villeger reaction, Cannizarro oxidation-reduction reaction.

UNIT III

Reduction Reactions **(10 Lectures)**

Introduction. Different reductive processes, Hydrogenation of alkenes, alkynes and aromatic rings, Carbonyl compounds – aldehydes, ketones, acids, ester and nitriles. Epoxides, Nitro, nitroso, azo and oxime groups, Hydrogenolysis. Sodium borohydride, sodium cyano borohydride, LAH, disobutyl aluminium hydride, tin hydride, trialkyl tinhydride, trialkyl silanes, alkoxy substituted LAH, DIBAL, diborane, diisoamyl borane, hexyl borane, 9-BBN, isopinocamphenyl and disiopinocamphenyl borane. Wolf-Kishner reduction, Clemensen reduction.

UNIT IV

Rearrangements **(16 Lectures)**

General mechanistic considerations-nature of migration, migratory aptitude, memory effects A detailed Study of the following rearrangements Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil- Benzilic Acid, Favorskii, Arndt Eistert synthesis, Neber, Beckmann, Hoffman, Curtius, Schmidt, Baeyer- Villiger, Shapiro reaction, Cope rearrangement, Claisen rearrangement, dienone-phenol, Wolf, Stevens (in cyclic systems) .

Free Radical Reactions **(6 Lectures)**

Types of free radical reactions, free radical substitution mechanism at an aromatic substrate, neighbouring group assistance, Reactivity for aliphatic and aromatic substrates at a bridgehead. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation. Coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction, Free Radical Rearrangement, Hunsdiecker reaction.

Suggested Books:

1. Carruthers, W. and Coldham, I. *Some Modern Methods of Organic Synthesis*, IV edition, Cambridge University Press, 2004.
2. March, Jerry. *Advanced Organic Chemistry: Reactions, Mechanism and Structure,* John Wiley, 7th edition, 2013.
3. Carry, F. A. and Sundberg, R.J. *Advanced Organic Chemistry*, Plenum, 5th edition, 2008.
4. Sykes, Peter. *A Guide Book to mechanism in Organic Chemistry*, 6th edition, Longman, 1989.
5. Morrison, R. T. and Boyd, R. N. *Organic Chemistry*, Prentice Hall, 6th edition, 1992.
6. Kalsi, P. S. *Organic Reactions and their Mechanisms,* New Age International Publishers, 2nd edition, 2000.
7. Mukherji, S.M. and Singh, S.P. *Reactions Mechanism in Chemistry*, Vol. I, II, III, Macmillan, 1985.
8. Aggarwal, O.P. *Organic Chemistry Reactions and Reagents,* Krishna Prakashan Media, 47th edition, 2011.

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Course Title: Inorganic Chemistry – II

Course Code: CHE508B

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Total Lectures: 60

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Inorganic chains, rings and cages **(15 Lectures)**

a) **Chains:** Catenation, heterocatenation (Silicate structures, silicate minerals, Zeolites), Intercalation Chemistry, One - dimensional semiconductors, isopolyanions and heteropolyanions.

b) **Rings:** Borazines, phosphazenes, phosphazenes polymers, other heterocyclic inorganic ring systems, homocyclic inorganic systems.

c) **Cages:** Cage compounds having phosphours, oxygen, nitrogen and sulphur: boron cage compounds, Boranes, Symmetric and asymmetric cleavage in diborane and tetraborane, STYX rule, carboranes and metallocene carboranes.

UNIT II

Transition metal cluster compounds **(15 Lecture)**

Introduction, metal carbonyl clusters; Low Nuclearity (M_3 and M_4) clusters: isoelectronic and isolobal relaltionships high nuclearity carbonyl clusters; hetero atoms in metal atom clusters, electron counting schemes for HNCC: HNCC of Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt. Hexanuclear clusters, Lower halide and chalcogenide clusters, octahedral metal halide, chalocogenide clusters,

triangular clusters, and solid state extended arrays, Compounds with M-M multiple bonds; Major structural types; quadrupole bonds, other bond orders in the tetragonal context, relation of clusters to multiple bonds, one dimensional solids.

UNIT III

Reaction Mechanisms of Transition Metal Complexes (25 Lectures)

Introduction, Ligand substitution reactions: Rates of ligand substitution, The classification of mechanisms, Ligand substitution in square-planar complexes, The nucleophilicity of the entering group, The shape of the transition state, Ligand substitution in octahedral complexes, Rate laws and their interpretation, The activation of octahedral complexes, Base hydrolysis, Redox reactions: The classification of redox reactions, The inner-sphere mechanism, The outer-sphere mechanism, Metal carbonyl reactions, reactions of binuclear carbonyls, associative reactions, species with 17 electron, The Marcus theory, doubly bridged inner-sphere transfer, other electron transfer reactions; two electron transfers, Non-complementary reaction, Ligand exchange via electron exchange, reductions by hydrated electrons, stereochemically non-rigid coordination compounds, Trigonal bipyramidal molecules, systems with coordination number six or more, isomerization and recombination’s, tris chelate complexes, metal carbonyl scrambling cluster, rotation within Coshells.

UNIT IV

Nuclear Chemistry (5 Lectures)

Introduction, Nuclear Reactions: fusion and fission, radio-analytical techniques and activation analysis, Radiation chemistry of Inorganic Solids.

Suggested Books:

1. Huheey, J.E.Inorganic Chemistry, Pearson, 5th Edition, 2009.

2.Cotton, F.A. and Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley eastern, 6th edition.

3. Shriver,D.F.,Atkins,P.W. and Langford,C.H. *Inorganic Chemistry,* ELMS, Oxford, 1990

4. William W. Porterfield, Inorganic Chemistry, 1st Edition.

5. K.F. Purcell and J.C. Kotz.An Introduction to Inorganic Chemistry.

6. Handbook of Nuclear Chemistry: Chemical applications of nuclear reactions and radiations, Volume 3, By Rezső G. Lovas, 2003

Course Title: Physical Chemistry II

Course Code: CHE509B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Chemical Kinetics **(15 Lectures)**

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation, concept of energy of activation, potential energy surfaces, steady state kinetics, Lindemann-Christiansen hypothesis, Hinshelwood treatment and Rice Ramsperger-Kassel-Marcus (RRKM) theories of unimolecular reactions, General features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and nuclear magnetic resonance method, Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen bromine and hydrogen-chlorine reactions).

UNIT II

Electrochemistry **(15 Lectures)**

Debye-Hückel theory of ion-ion interaction and activity coefficient, ionic strength, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ion-

solvent interaction on activity coefficient. Physical significance of activity coefficients, mean activity coefficient of an electrolyte.

Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance, Debye-Falkenhagen effect, Wein effect, D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment), Modification of D-H-O theory to account for ion-pair formation.

UNIT III

Surface Chemistry and Catalysis **(20 Lectures)**

Gibbs adsorption equation, Langmuir adsorption isotherm, BET adsorption isotherm, its derivation and applications.

Study of surfaces by STM, SEM, Heterogeneous catalysis, surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons, activation energy for surface reactions.

Colloidal State

Classification of colloids, Hardy-Schulze Law, gold number, electrical properties of colloids, electrical double layer and its structure, Stern's theory of double layer, zeta-potential, electrophoresis and electro osmosis, emulsions and their classification, emulsifiers, gels and their classification, Thixotropy, Application of colloids.

Micelles: Surface active agents, classification of surface active agents, micellisation, hydrophobic interactions, critical micellar concentration, thermodynamics of micellization-phase separation & mass action models, reverse micelles.

UNIT IV

Macromolecules **(10 Lectures)**

Basic concepts, Kinetics of Polymerization, Mechanism and Kinetics of chain growth polymerization, free-radical, cationic, anionic and coordination polymerization, Mechanism and Kinetics of step-growth polymerization, Molecular mass of polymers, Significance of average molecular mass, Poly-dispersity, Determination of molecular mass by (osmometry, viscosity, diffusion, light scattering, and sedimentation methods.

Suggested books:

1. Chemical Kinetics, K.J. Laidler, McGraw Hill.
2. Kinetics and Mechanism, A. A. Frost and R.G. Pearson, John Wiley and Sons.
3. Electrochemistry, S. Glasstone, Affiliated East-West Press.
4. Physical Chemistry, G.W. Castellan, Narosa.
5. Heterogeneous Catalysis: Fundamentals and Applications, Julian R.H. Ross, Wiley-VCH; 2nd, Revised and Enlarged Edition edition (October 1, 2007)
6. Concepts of Modern Catalysis and Kinetics, I. Chorkendorff and J. W. Niemantsverdriet
7. Moroi, Y. Micelles: Theoretical and Applied Aspects, 1st edition, Plenum Press, 1992.
8. Bockris, John O'M; Reddy, Amulya K.N. Modern Electro-Chemistry, 2nd edition, Plenum Press, New York, 1998.
9. Adamson, Arthur W. Physical Chemistry of Surfaces, 4th edition, A Wiley-Interscience Publication, 1982.
10. Polymer Chemistry, Billmayer
11. Polymer Chemistry, Gowarikar
12. Principles of Polymerization, Geroge Odian.

CourseTitle: Spectroscopy-I

Course Code: CHE510B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn advance spectroscopy. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the advance spectroscopy and its applications. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

General Features of Spectroscopy (5 Lectures)

Units and conversion factors. Introduction to spectroscopy, Nature of radiation. Energies corresponding to various kinds of radiation, Experimental techniques, intensities of spectral lines, Selection rules and transition moments, Line widths, broadening.

Nuclear Magnetic Resonance Spectroscopy (20 Lectures)

PMR: Natural abundance of ^{13}C, ^{19}F and ^{31}P nuclei; The spinning nucleus, effect of external magnetic field, processional motion and frequency, Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effect; Integrals of protons, proton exchange, spin-spin coupling- splitting theory, one, two and three bond coupling, virtual, long range and allylic coupling, magnitude of coupling constant; factors affecting the coupling constant, Chemical and magnetic equivalence, First and second order spectra, A_2, AB, AX, AB_2, AX_2, A_2B_2 and A_2X_2 spin systems, Simplification of complex spectra (solvent effect, field effect, double

resonance and lanthanide shift reagents), CW and FT NMR, Relaxation processes, T1 and T2 measurements, Applications of PMR in structural elucidation of simple and complex compounds.

UNIT II

^{13}C-NMR Spectroscopy (10 Lectures)

Resolution and multiplicity of ^{13}C NMR, ^{1}H-decoupling, noise decoupling, broad band decoupling; Deuterium, fluorine and phosphorus coupling; NOE and origin of nuclear overhauser effect, off-resonance, proton decoupling, Structural applications of 13C-NMR, pulse sequences, pulse widths, spins and magnetization vectors, DEPT, INEPT, Introduction to 2D-NMR, COSY, NOESY, HSQC spectra.

UNIT III

Mass Spectrometry (15 Lectures)

Introduction, methods of ionization EI & CI, Brief description of LD, FAB, SIMS, FD etc., Ion analysis methods (in brief), isotope abundance, Metastable ions, general rules predicting the fragmentation patterns. Nitrogen rule, determination of molecular ion peak, index of H deficiency, fragmentation patterns for aliphatic compounds, amines, aldehydes, Ketones, esters, amides, nitriles, carboxylic acids ethers, aromatic compounds etc.

UNIT IV

UV and Visible Spectroscopy of organic molecules (10 Lectures)

Measurement techniques, Beer – Lambert's Law, molar extinction coefficient, oscillator strength and intensity of the electronic transition, Franck-Condon Principle, Ground and first excited electronic states of diatomic molecules, relationship of potential energy curves to electronic spectra, Chromophores, auxochromes, blue shift, red shift, hypo and hyperchromic effect, transitions in organic molecules, Woodward rules for conjugated dienes, unsaturated carbonyl groups, extended conjugation and aromatic sterically hindered systems, Quantitative applications.

Suggested Books:

1. Drago, R.S. *Physical Methods in Chemistry,* Reinhold Publishing Corporation, 1965.

2. Silverstein, R.M. Bassler, G.C. and Morrill, T.C. *Spectrometric Identification of Organic Compounds,* Wiley, 1991.

3. Kemp, W. *Organic Spectroscopy*, Macmillan, 1987.

4. Dyer, J. R. *Application of Absorption Spectroscopy of Organic Compounds*, Prentice Hall, 1965.

5. Williams, D. H. and Fleming, I. *Spectroscopic Problems in Organic Chemistry*, McGraw Hill, 1967.

6. Barrow, G.M. *Introduction to Molecular Spectroscopy*, McGraw Hill.

7. Banwell, C.N. *Fundamentals of Molecular Spectroscopy*, McGraw Hill, 1966.

8. Pavia, D.L., Lampan, G.M. and Kriz, G. S. *Introduction to Spectroscopy*, Hartcourt College Publishers, 5th Edition, 2013.

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Course Title: Organic Chemistry Lab II

Course Code: CHE511B

Time: 04 Hours

Course Objectives:

This course is intended to learn the basic experimental concepts of Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post-graduation in this course.

Preparation of the following organic compounds:

1. Hydroxynaphthaldehyde (Reimer tiemannReaction)
2. Benzoin, BenzilandBenzilic acid.
3. Benzophenone, Benzophenoneoxime, Benzanilide (Beckmann Rearrangement).
4. Alkylation of diethyl malonate with benzyl chloride

Qualitative Analysis of mixtures of organic solids:

Separation of the compounds and their identification through various steps, derivative preparation, checking the purity of components by melting point.

Suggested Books:

1. Harwood, L.M. and Moody, C.J. *Experimental Organic Chemistry*, BlackwellScientific Publishers, 1st edition, 1989.

2. Vogel, A.I. *Text Book of Practical Organic Chemistry*, ELBS, LongmanGroup Ltd.,4th edition, 1978.

3. Mann, F.G. and Saunders, B.C. *Practical Organic Chemistry*, 4th edition, NewImpression, Orient Longman Pvt. Ltd., 1975.

4. Leonard, J. and Lygo, B. *Advanced Practical Organic Chemistry*, Chapman and Hall,1995.

Course Title: Physical Chemistry Lab -I

Course Code: CHE512B

Time: 04 Hours

Course Objectives:

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Expected Prospective:

The students will be able to understand the basic objective of experiments in organic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

1. Viscosity:

(i) Determination of percentage composition of a liquid mixture by viscosity measurement.

(ii) Determination of molecular weight of a high polymer (say polystyrene) by viscosity measurement.

2. Surface Tension:

(i) Determination of Parachor value of $>CH_2$ group.

(ii) To measure interfacial tension and to test the validity of Antonoff's rule.

(iii) To compare cleansing power of two detergents.

(iv) To determine the critical micelle concentration of a soap by surface tension method.

3. Solubility:

(i) Determination of solubility of an inorganic salt in water at different temperatures and hence to draw the solubility curve.

(ii) To study the effect of addition of an electrolyte on the solubility of an organic acid.

(iii) To study the variation of solubility of $Ca(OH)_2$ in NaOH solution and hence determine the solubility product.

4. Colloidal State:

(i) To compare the precipitation power of Na^{+}, Ba^{2+}& $A1^{3+}$ ions for As_2S_3 sol.

(ii) To study interaction between arsenious sulphide and ferric hydroxide sol.

5. Density:

Determine the partial molar volume of ethanol in dil. aqueous solution at room temperature.

Suggested Books:

1. Levitt, B.P. *Findlay's Practical Physical Chemistry*, 9th edition, Longman Group Ltd., 1973.

2. Matthews, G. Peter *Experimental Physical Chemistry*, 1st edition, Oxford University Press, 1985.

3. Shoemaker, D.P.; Garland, C.W.; Nibler, J.W. *Experiments in Physical Chemistry*, 6th edition (International Edition) McGraw Hill Inc., 1996.

4. Khosla, B.D.; Garg, V.C. Gulati, A. *Senior Practical Physical Chemistry*, 11th edition, R. Chand and Co., 2002.

5. Yadav, J. B. *Physical Chemistry Practical*.

Scheme of Courses M.Sc.

M.Sc. (Hons.) Chemistry

Semester 3

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE601B	Core	Organic Chemistry-III	4	0	0	4
2	CHE602B	Core	Inorganic Chemistry-III	4	0	0	4
3	CHE603B	Core	Physical Chemistry-III	4	0	0	4
4	CHE604B	Core	Spectroscopy-II	4	0	0	4
5	CHE606B	Core	Inorganic Chemistry Lab-II	0	0	4	2
6	CHE607B	Core	Physical Chemistry Lab-II	0	0	4	2
7	CHE608B*	Core	Seminar and Literature Survey	0	0	0	2*
8	CHE620B*	Core	Advance Chemistry Lab-I	0	0	8	4*
	Department Elective-I						4
	Total						26/28*
Department Elective-I							
7	CHE605B	Elective	Advanced Electrochemistry	4	0	0	4
8	CHE617B	Elective	Synthetic Organic Chemistry	4	0	0	4
9	CHE614B	Elective	Molecules of Life	4	0	0	4
10	PHY670	Elective	Nanoscience and Nanotechnology	4	0	0	4

L: Lectures T: Tutorial P: Practical Cr: Credits

***Only 30 students in the class will be enrolled for research projects based upon their merit/performance in MSc first year. The students with research projects will study CHE608B of 2 credits and the others will study CHE620B of 4 credits in the third semester.**

Course Title: Organic Chemistry-III (Pericyclic Reactions and Photochemistry)
Course Code: CHE601B

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Total Lectures: 60

Course Objectives:
This course is intended to teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. (2nd Year) in the subject of Chemistry has been framed as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Expected Prospective:
This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Pericyclic Reaction. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Pericyclic Reactions **(18 Lectures)**

Introduction, Construction of molecular orbitals and its symmetry in conjugated polyenes (ethylene, 1,3-butadiene, 1,3,5-hexatriene), & in conjugated ions and radicals (allyl, pentadienyl, and heptatrienyl system). Frontier molecular orbitals and theory of pericyclic reactions. Classification of pericyclic reactions and their complete description. Woodward-Hoffmann correlation diagrams of pericyclic reactions. Description of pericyclic reactions by Frontier molecular orbitals (FMO) and Perturbation molecular orbitals (PMO) methods. Electrocyclic reactions and its theory (conrotatory and disrotatory motions in 4n, 4n+2 and in conjugated ions and radicals). Cycloadditions reactions and its theory (stereochemistry, orientation effect, intermolecular, and intramolecular reactions)- antara facial and suprafacial additions in 4n and

4n+2 systems. 2+2 cycloadditiionreactions, Chelotropic reactions and 1,3-dipolar cycloadditions reactions.

UNIT II

Sigmatropic rearrangements **(12 Lectures)**

Introduction, Classification of sigmatropic shift, Mechanism of sigmatropic shift reactions with FMO and PMO method. Sigmatropic shifts of hydrogen and carbon moieties (Suprafacial and antarafacial shift). [3,3] and [5,5] sigmatropic rearrangements and its stereochemistry. Cope, Oxa-Cope, Claisen, and Aza-Cope rearrangement. Fluxional tautomerism or molecules. Intermolecular and intramolecular group transfer reactions (Ene reaction).

PhotochemicalReactions **(5 Lectures)**

Introduction and basic principles of photochemistry, Electronic transitions, spin multiplicity.Types of excitations, the fate of excited molecule (Jablonski diagram), Description of physical processes. Photosensitization and quenching. Laws of Photochemistry. Quantum yield – actinometry, and its description.

UNIT III

Photochemistry of Alkenes and Dienes **(5 Lectures)**

Photochemistry of alkenes: *Cis-Trans* isomerization and dimerization of alkenes. Photochemistry of conjugated dienes.

Photochemistry of Aromatic Compounds **(5 Lectures)**

Photoisomerization of benzene and substituted benzene. Photoaddition of alkenes to aromatic benzenoid compounds. Photosubstitution of aromatic compound.

UNIT IV

Photochemistryof Carbonyl Compounds (10 Lectures)

α- Cleavage (Norrish type-I reaction) of acyclic saturated ketone, saturated cyclic ketone (cyclohexanones, cyclopentanones, cyclobutanones). β-cleavage reaction. Norrish type-II reaction.Intramolecular hydrogen abstraction (γ hydrogen abstraction). Intermolecular hydrogen abstraction (Photoreduction). Paterno-Buchi reactions. Cyclohexenone rearrangement (Lumiketone rearrangement and Di-π methane type rearrangement). Rearrangement of dienones. Photo rearrangement of β, γ-unsaturated ketones (1,2-acyl shift and 1,3-acyl shift). Aza-Di-π methane rearrangement. Di-π methane rearrangement.

Miscellaneous Photochemical Reactions (5 Lectures)

Rearrangement of aromatic compounds (Photo-Friesrearrangement). Photochemical oxidations. The Barton reaction. The Hoffmann-Loeffler-Freytag reaction. Photochemical formation of smog. Photochemistry of vision.

Suggested Books:

1. Mukherji,S.M. *Pericyclic reactions,* Macmillan, 1979.
2. Turro, N.J. and Benjamin, W.A. *Molecular Photochemistry,* University Science Books, U.S., 1991.
3. Cox, A. and Camp, T. *Introductory Photochemistry,*McGrawHill,1972.
4. Horsepool, W.M. *Organic Photochemistry,* Ellis Horwood, 1992.
5. Kalsi, P.S. *Organic Reactions and their Mechanisms,* New Age International, 2^{nd} edition, 2000.
6. *Jagdamba Singh and Jaya Singh:* Photochemistry and pericyclic reactions.

Course Title: Inorganic Chemistry–III (Organometallics)

Course Code: CHE602B

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Total Lectures: 60

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective: This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Structure and Bonding **(20 Lectures)**

*Organometallic chemistry***:** Introduction and development, Scope of Organometallic Chemistry, Classification of Organometallic Compounds

The 18 Valence Electron Rule: Introduction, 18 electron rule, counting of electrons and finding metal-metal bonds, Violation of 18 electron rule and related problems.

Alkyl, Aryl and Ligands with Higher Hapticity:

(i) Sigma bonded alkyl groups as ligands: Synthesis of metal-alkyl compounds, β-hydride elimination, σ-bonded η^1-aryl ligands.

(ii) Cyclic and acyclic polyenyl π-bonded ligands:

Cyclopentdienyl (Cp-), Synthesis of Cp based sandwich compounds, Structure and properties of Cp_2M complexes, Ferrocene: general properties and applications. Structure and bonding of ferrocene, Basic chemical reactions of Ferrocene, Reactions of Acetyl Ferrocene and formyl Ferrocene, lithiated ferrocenes and their reactions, Reactions of other metal-sandwich compounds, Bent sandwich compounds, Schwartz reagent and hydrozirconation, Chemistry of Cp*, Chemistry of arene sandwich compounds

Allyl groups as ligands, 1,3-Butadiene complexes, Cyclobutadiene complexes, Cycloheptatriene and Cyclooctatetraene as ligands. Davies-Green-Mingos (DGM) rules.

UNIT II

Complexes with Metal-Carbon multiple bonds **(13 Lectures)**

Metal Carbene: Structure of Fischer and Schrock carbenes, synthesis of Fischer and Schrock carbene complexes. Tebbe's reagent and Petasis reagent Importance of metal carbene complexes.

Metal Carbyne: Structure, synthesis and properties carbyne complexes

N-Heterocyclic Carbene: Structure, synthesis and importance of N-Heterocyclic Carbene complexes.

Metal clusters: binuclear and polynuclear, metal metal bond in low nuclearity and high nuclearity carbonyl clusters. Capping rule: limitation and exceptions of capping rule, polyhedral skeletal electron pair approach. Metal Clusters with main group elements, Jemmis' mno rules

UNIT III

Applications of Organometallic Complexes to Catalysis **(18 Lectures)**

Catalysis, Thermodynamics of catalysis, Terminology in catalysis-turnover, turnover number, turnover frequency, enantioselectivity and regioslectivity of catalyst. Sequences involved in a catalyzed reaction, Heterogeneous catalysis, catalytic converter in automobiles.

Catalytic hydrogenation: classification of hydrogenation catalysts, catalytic cycle of Wilkinson's catalyst, iridium and ruthenium based catalysts, directing effects in catalytic hydrogenation, Hydrogenation by lanthanide organometallic compounds, catalytic asymmetric hydrogenation.

Hydroformylation: Cobalt catalysts and phosphine modified cobalt catalysts, Rhodium-phosphine catalysts, factors affecting the n/iso ratio of hydroformylation products;

Methanol Carbonylation and Olefin Oxidation: Monsanto, Cativa and Wacker Processes;

Olefin metathesis: A synthetic tool, olefin metathesis catalysts and properties. Synthesis of Grubbs and Schrock catalysts. Ring opening metathesis, cross metathesis, Ring closing metathesis, Ring opening metathesis polymerisation.

UNIT IV

Bioorganometallic Chemistry **(9 Lectures)**

Vitamin B_{12} coenzyme: discovery and structure, Role of organometallics in heavy metal poisoning: Mercury and Arsenic poisoning; organometallic compounds as drugs: ruthenium based anticancer drugs. Ferrocene based drugs: ferroquine and ferrocifen; Organometallic radiopharmaceutical, Organometallics tracers, ionophores and sensors.

Suggested Books:

1. J.E. Huheey, Inorganic Chemistry, Principles of Structure and Reactivity, Harper Inter-Science.
2. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th edition, Wiley Inter-Science.
3. B.D. Gupta and A.J. Elias, Basic Organometallic Chemistry, Universities Press.
4. A. Salzer and E. Elschenbroich, Organometallics, A Concise Introduction, VCH.
5. D. Astruc, Organometallic Chemistry and Catalysis, Springer.

Course Title: Physical Chemistry III

Course Code: CHE603B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Mathematical Preparation **(15 Lectures)**

Operators and observables, normality and orthogonally of functions, Hermitian operators.

Quantum Theory: Introduction and principles and applications

Black Body radiation, Planck's radiation law, photoelectric effect, Compton effect, De-Broglie hypothesis, the Heisenberg's uncertainty principle, eigen value equation, Hamiltonian operator, Interpretation of Ψ, Solution of particle in one, two and three dimensional box, degeneracy. Postulates of quantum mechanics, the linear harmonic oscillator, and the rigid rotator, Laddler operator method for angular momentum.

UNIT II

The Approximation Methods **(15 Lectures)**

Need for approximation methods, Perturbation and Variation methods and their application to Helium atom.

Chemical Bonding

Chemical bonding, linear combination of atomic orbitals, overlap integral, coulomb integral, bond order, charge density calculations for ethylene, allyl system, butadiene system, cyclo butadiene, cyclo propenyl system.

UNIT III

Nanochemistry **(12 Lectures)**

Properties of nanomaterials, General Method of synthesis, Characterization of nanomaterials, Material Self-assembly, Quantum dot, Nanoscale Materials, Fullerenes, Carbon nanotubes, nanowires, Nanorods, Dendrimers, Biological Nanomaterials, General Applications of Nanochemistry.

UNIT IV

Nuclear and Radiochemistry **(18 Lectures)**

Nuclear stability and binding energy, Mass and binding energy, Nuclear fission and nuclear fusion, fission cross section, chain fission, fission product and fission yield. Interaction of nuclear radiation with matter,

Photochemistry

Difference between thermal photochemical reactions, laws of photochemistry, Jablonski diagram, qualitative description of fluorescence, phosphorescence, non- radiative processes (IC, ISC), quantum yield, photosensitized reactions, nuclear geometries of electronically excited states, Excimers and Exciplexes, kinetics of photochemical reactions, chemiluminescence.

Books Suggested:

1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
2. Quantum Chemistry, I.M. Levine, Prentice Hall.
3. Essentials of Nuclear Chemistry, 4th Edition (1995), H.J. Arnikar, Wiley Eastern, New Delhi.
4. Nuclear & Radiochemistry, 3rd Edition (1981), G. Fridlander, J.W. Kennedy, E. S. Macias, and J. M. Miller, John Wiley, New York.
5. Quantum Chemistry, R. K. Parsad, 3rd Edition, 2006

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Course Title: Spectroscopy -II

Course Code: CHE604B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

This course is intended to learn the basic concepts of Spectroscopy. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective: This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Spectroscopy. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post-graduation in this course.

UNIT I

Pure Rotational Spectra **(8 Lectures)**

Classification of molecules according to their moment of inertia. Rotational spectra of diatomic molecules (rigid rotator), Intensities of spectral lines, isotopic substitution effects, non-rigid rotator, polyatomic linear and symmetric top molecules, Stark effect.

Vibrational Spectroscopy **(8 Lectures)**

Theory of Infrared Absorption: Harmonic and anharmonic oscillators, absorptions of radiation by molecular vibrations, selection rules, force constant, frequency of vibrational transitions of HCl, vibrations in a polyatomic molecule, 3N-6 and 3N-5 rules, types of vibrations, overtones, combination and difference bands, examples of CO_2, SO_2 and H_2O, Fermi resonance, group vibrations.

UNIT II **(10 Lectures)**

Raman Spectroscopy: Introduction, selection rules, anisotropic polarizabilty, Stokes, anti-Stokes lines, vibrational Raman spectra of CO_2 and H_2O, polarized and depolarized Raman Lines, rule of mutual exclusion.

Determination of IR/Raman Active Modes: Significance of nomenclature: used to describe various vibrations, use of symmetry considerations to determining the number of active infrared and Raman Lines (C_2v molecules).

Applications: Physical state of a sample, cells used, Application of IR in structure elucidation of organic compounds-carbonyls and effect of substituents on it, C-H, NH, O-H vibrations and H-bonding- unsaturated, mono- and disubstituted aromatic compounds, metal-ligand vibrations, group frequencies of complex ligands-CN stretching and effect of coordination on it, nitro and nitrite and C=O ligands and effect of their coordination with metal ions.

UNIT III

Nuclear Quadruple Resonance Spectroscopy **(8 Lectures)**

Introduction, experimental considerations, fundamentals of NQR spectroscopy, origin of EFG, measurement of energy differences between two nuclear spin states, the asymmetry parameter, effects of the magnetic field, interpretation of the spectra, application of the technique to halogen compounds, group elements, transition metals.

Mossbauer Spectroscopy **(8 Lectures)**

Experimental considerations, the spectrum and its parameters, simple spin states (I =1/2, 3/2), higher spin states (I > 3/2), magnetic splitting significance of parameters obtained from spectra, quadruple splitting, additive model, interpretation of Mossbauer spectra of ^{57}Fe, ^{119}Sn.

UNIT IV

Electron Paramagnetic Resonance Spectroscopy **(9 Lectures)**

Introduction, principle, Presentation of spectrum, hyperfine splitting in isotropic systems involving more than one nucleus, ESR spectrum of benzene radical anion, methyl radical, cyclopentedienyl radical, cycloheptatrienyl radical, pyrazine anion, pyrazine anion with ^{23}Na and ^{39}K counter ion and Nitrosyl nitroxide, Factors affecting magnitude of g values, zero field splitting and Krammer's degeneracy.

Photoelectron Spectroscopy **(9 Lectures)**

Introduction, photoelectron spectroscopy, chemical shift, X-ray photoelectron Spectroscopy, ESCA, ultraviolet photoelectron spectroscopy (UPS), exchange splitting and shake up process.

Suggested Books:

1. R.S. Drago, Physical Methods in Chemistry, W.B. Saunders Company.

2. R.V. Parish, NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, Eds Elis Horwood.

3. Skoog D.A., D.M.West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical chemistry, Pubs: Brooks/Cole, 2004.

4. R.M. Silverstein, G.C. Bassler, T.C. Morrill, "Spectrometric Identification of Organic Compounds, Wiley 1991.

5. W. Kemp, Organic Spectroscopy, Macmillan, 1987.

6. J. R. Dyer, Application of Absorption Spectroscopy of Organic Compounds, Prentice Hall, 1965.

7. D. H. Williams, I. Fleming, Spectroscopic Problems in Organic Chemistry, McGraw Hill, 1967.

8. G.M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill.

9. C.N. Banwell, Fundamentals of Molecular Spectroscopy, McGraw Hill, 1966.

10. D.L. Pavia, G.M. Lampan and G. S. Kriz, Introduction to Spectroscopy, Hartcourt College Publishers, 2001.

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Course Title: Inorganic Chemistry Lab -II

Course Code: CHE606B

Time: 04 Hrs

Course Objectives:

This course is intended to learn the basic concepts of Inorganic Chemistry Laboratory. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various experiments have been designed to enhance laboratory skills of the postgraduate students.

Expected Prospective:

The students will be able to understand the basic objective of experiments in inorganic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

EXPERIMENT

1 Preparation of mercury tetraisothiocyanatocobaltate (II). Determination of its magnetic moment and interpretation of its IR spectrum.

2 Preparation of nitro-and nitrito-pentaamminecobalt (II) chlorides from chloropentaamine cobalt (III) chloride. Recording and interpreting their electronic and IR spectra.

3 Heating the nitro and nitrito isomers at serial 2 to 15^{o}C in an oven for 3 h and recording the infrared spectra again and compare those with the spectra recorded before the isomers were heated.

4 Preparation and resolution of tris (ethylenediamine)cobalt(II) ion. Measurement of optical rotation of these resolved complexes.

5 Preparation of diaquotetraacetatedicopper (II). Determination of its magnetic susceptibility and interpretation of E.P.R., electronic absorption and IR spectra.

6 Preparation of bis (2,4-pentanedione)vanadium(IV) acetate and its piperidine or pyridine complex. Study of both the complexes with the help of infrared, UV-vis spectroscopy and magnetic susceptibility.

7 Preparation of hexaamminenickel(II)chloride and tris(ethylenediamine)nickel(II) chloride. Interpretation of their electronic absorption spectral data and calculation of β and 10Dq values. Measurement of magnetic susceptibility, calculation and interpretation of the values.

8 Preparation of lead tetraacetate.

9 Preparation of potassium trioxalatoaluminate(III) trihydrate. Its TGA and DTA studies and its interpretation of its IR data.

10 Preparation of disulphur dichloride.

11 Preparation of sodium tetrathionate, potassium dithionate, and interpretation of their IR spectra.

12 Preparation of cis-and trans-potassium dioxalatodiaquochromate (III). Interpretation of their IR and selectronic absorption spectral data. Calculation of β and 10 Dq values.

13 Preparation of iron (II) oxalate and potassium trioxalateferrate(III). Interpretation of their magnetic data, E.P.R. and Mossbauer spectra.

14 Preparation of nitrosylbis-(diethyldithiocarbamato)iron(II) and interpretation of its IR and EPR spectra.

15 Preparation of chromium (II) acetate hydrate.

16 Preparation of Manganese (II) phthalocyanine. Interpretation of its IR, and electronic absorption spectra.

Suggested Books:

1 Marr, G. and Rockett, B.W. *Practical Inorganic Chemistry*, Van Nostrand Reinhold Company.

2 Jolly,W.L. *The Synthesis and Characterization of Inorganic Compounds.* Prentice Hall.

Course Title: Physical Chemistry Lab -II

Course Code: CHE607B

Time: 04 Hours

Course Objectives:

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Expected Prospective: The students will be able to understand the basic objective of experiments in organic chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills.They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

1. Polarimetry:

To study the inversion of cane sugar by optical rotation measurement.

2. **Potentiometry:**

(i) Determination of valence of mercurous ion.

(ii) Determination of pH value using quinhydrone electrode.

(iii) Determination of heat of reaction, equilibrium constant and other thermodynamic functions for:

(a) $Zn + Cu^{+2}$ $Zn^{+2} + Cu$

(b) $Zn + Pb^{+2}$ $Zn^{+2} + Pb$

(iv) Determination of hydrolysis constant of aniline hydrochloride electrometrically.

3. **Flame Photometry:**

(i) Determination of Na^+ & K^+ when present together.

(ii) Determination of Lithium/ Calcium/ Barium/ Strontium.

4. **Transition Temperature Determination:**

Determination of transition temperature of $MnCl_2$ by Dielatometric method.

Suggested books:

1. Levitt, B.P. *Findlay's Practical Physical Chemistry*, 9th edition, Longman Group Ltd., 1973.

2. Matthews, G. Peter *Experimental Physical Chemistry*, 1st edition, Oxford University Press, 1985.

3. Shoemaker, D.P.; Garland, C.W.; Nibler, J.W. *Experiments in Physical Chemistry*, 6th edition (International Edition) McGraw Hill Inc., 1996.

4. Khosla, B.D.; Garg, V.C. Gulati, A. *Senior Practical Physical Chemistry*, 11th edition, R. Chand and Co., 2002.

Course Title: Advance Chemistry Lab-I

Course Code: CHE620B

Time: 08 Hours

Course Objectives:

To teach the advance techniques in the Chemistry lab. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Expected Prospective: The students will be able to understand the advance techniques required to synthesize, analyze different chemical compounds, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

Advance Inorganic Chemistry Lab

1. Synthesis of first row transition Metal complexes with reduced Schiff base ligands and their characterisation with various techniques, like UV-Visible spectroscopy, IR spectroscopy and Thermogravimetric analysis.
2. Synthesis of Cu (I) and Ag (I) salts with different counter anions and their characterization with IR spectroscopy.
3. Learning various methods of crystallisation (slow evaporation, layering, solvent diffusion, slow cooling, vapour diffusion and vacuum sublimation) and growing crystals of reduced Schiff base ligands and metal complexes as synthesised in steps 1 and 2.
4. Synthesis of ZnO and CdO nanoparticles and their characterization by powder X-ray studies and scanning electron microscopy.
5. Study for the effect of Crystal field stabilization energy on the electronic spectra of transition metal complexes using UV-Visible spectroscopy.

Reference Books

1. Jolly,W.L. *The Synthesis and Characterization of Inorganic Compounds.* Prentice Hall.
2. Marr,G. and Rockett, B.W. *Practical Inorganic Chemistry,* Van Nostrand Reinhold Company.
3. Pass, G. and Sutcliffe, H *Practical Inorganic Chemistry:Preparations, reactions and instrumental methods* , Springer Netherlan
4. Girolami, G. S., Rauchfuss, T. B., and Angelici, R. J. *Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual* 3rd Edition, University Science Books
5. Svehla, G. and Sivasankar, B. *Vogel's Qualitative Inorganic Analysis (revised),* Pearson, 7th edition, 1996

Advanced Physical Chemistry Lab

1. Understanding error, accuracy and precision by measuring physical parameters.
2. Determination of physical properties of materials
3. Advanced experiments involving chemical thermodynamics, chemical equilibria, chemical Kinetics, electro chemistry, spectroscopy, photochemistry and macromolecules.

Reference Books

1. Halpern, A. M.; McBane, G. C. *Experimental Physical Chemistry: A Laboratory Prescribed Book*, W. H. Freeman, 3rd edition, 2006.
2. Viswanathan, B.; Raghavan, P. S.; *Practical Physical Chemistry*, Viva Books, 2010.
3. Hein, M.; Peisen, J. N.; Miner, R. L.; *Foundations of College Chemistry in the Laboratory*, John Wiley & Sons Inc., 2011.
4. Dave, R. K.; *Experiments in Physical Chemistry*, Campus Books International, 2011.

Computational Chemistry Laboratory

Experiments involving optimization of molecular energies and geometries, calculation of thermodynamic parameters, kinetic parameters, prediction of spectral data.

Reference Books

1. J.B. Foresman, AEleen Frisch, *Exploring Chemistry with Electronic Structure Methods*, Gaussian, Inc., 2nd Ed., 2000

2. Frank Jensen, *An Introduction to Computational Chemistry*, John Wiley & Son Ltd., 1998.

3. Christoper Cramer, *Essentials of Computational Chemistry*: Theories and Models, John Wiley & Sons, 2002.

Course Title: Advanced Electrochemistry

Course Code: CHE605B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post-graduation in this course.

UNIT I

Electrochemistry of Solutions I **(22 Lectures)**

Ion-solvent interactions, the Born model, electrostatic potential at the surface of a charged sphere, Born expression for the free energy of ion-solvent interactions, structural treatment of ion-solvent interactions, ion-dipole moment, evaluation in the ion-dipole approach to heat of solvation, solvation number, static and dynamic pictures of ion-solvent interactions, hydration number, dielectric constant of water and ionic solutions, dielectric constant of liquids containing associated dipoles, ion – solvent nonelectrolyte interactions, change in solubility of non-electrolyte due to primary and secondary solvations.

UNIT II

Electrochemistry of Solutions II **(18 Lectures)**

Debye-Huckel treatment, and its extension, ion solvent interaction, Debye-Huckel-Jerrum model, Thermodynamics of electrified interface equations, derivation of electro capillarity, Lippmann equations (surface excess), Methods of determining structures of electrified interfaces, Guoy-Chapman, Stern. Over potentials, exchange current density, derivation of Butler-volmer equation.

Tafel plots. Quantum aspects of charge transfer at electrode solution interfaces, quantization of charge transfer, tunnelling Semiconductor interfaces- theory of double layer interfaces, effects of light at semiconductor solution interface.

UNIT III

Electro catalysis **(8 Lectures)**

Influence of various parameters, Hodges-Huxley equation, Nernst-Plank equation, H-electrode, polarography, theory of Ilkovic eqn, (excluding derivation), Half wave potential & its significance, electrocardiography

UNIT IV

Corrosion and its Control **(12 Lectures)**

Corrosion in Metal and alloys, causes of corrosion, Effects of Corrosion, Corrosion cell, Types of corrosion, Electrochemical corrosion, Corrosion control, Protective Coatings, Metal Finishing, Electroplating, Effect of plating variables on the Nature of Electro deposit, Surface preparation, Electroplating of Chromium, silver, Electro less plating.

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Suggested Books:

1. Electrochemistry, S. Glasstone, Affiliated East-West Press.
2. Modern Electrochemistry, J. O' M.Bockris & A.K.N. Reddy, Vol. II, A Plenum/Rosetta Edition.
3. Electrochemical methods, Allen J. Bard, Wiley India.
4. Handbook of Electrochemistry, Cynthia Zoski, Ist Ed., Elsevier.

Course Title: Synthetic Organic Chemistry

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Code: CHE617B

Total Lectures: 60

Course Objectives:

This course is intended to learn the basic concepts of Synthetic Organic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the students.

Expected Prospective: This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Synthetic Organic Chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers.

UNIT I

(18 Lectures)

An introduction of synthesis and synthetic equivalents. General principle of disconnection approach; Importance of order of event in organic synthesis. Introductory meaning of one CX and two C-X groups disconnection. Reversal of polarity (umpolung),New application of organosilicone compounds, cyclization reactions of carbene and nitrenes.

Protective Groups :Principle of protection of alcoholic, amino, carbonyl and carboxylic groups with suitable examples from synthetic point of view.

Synthesis of alkene, β–elimination pyrolytic syn elimination, synthesis of allyl alcohol, sulphoxidesulphenate rearrangement, through phosphorous ylid, decarboxylation of β–lactum stereo selective synthesis of tri-tetra substituted alkenes through use of acetylenes. Use of nitro compounds in organic synthesis. Fragmentation of sulphonates, oxidative decarboxylation of carboxylic acids. Decomposition of toulene p-sulphonylhydrazones, stereospecific synthesis from – 1,2-diols. Stereoselective route to γ,δ–carbonyl compounds.

UNIT II **(12 Lectures)**

C-C bond formation: Generation and importance of enolate ion, regioselectivity, stereoselectivity. Generation of dianion and their alkylation, alkylation of relatively acidic methylene groups. Hydrolysis and decarboxylation of alkylated product, O-Vs-C alkylation, C-alkylation of vinyl group, aryl group. Formation of enamines and alkylation. Alkylation of carbon by conjugate additions.

One group C-C - disconnection: Disconnection of simple alcohols, of simple olefins, carbonyl compounds control in synthesis, friedal craft's type examples.

UNIT III

(15 Lectures)

Reaction of carbon nucleophiles with carbonyl group: Condensation process favoured equilibrium by dehydration of aldol products, under acidic and basic conditions, Amine catalysed condensation, Mannich Reaction, Nucleophilic addition, Cyclization process, Derzen, Perkin, Stobbe reaction. Sulphur slides, phosphorous ylides and related spices as nucleophiles.

Diels Alder Reaction: General feature dienophile diene, intramolecular Diels Alder reaction stereochemistry and mechanisms, photo sensitized Diels Alder Reaction, homo Diels Alder reaction, ene synthesis, cycloaddition reaction of allyl cations/anions. Retro-Diels Alder's Reaction.

UNIT IV

(15 Lectures)

Two Group Disconnections approach, 1,3-Difunctionalized compound -α-hydroxy carbonyl compounds. α,β-unsaturated carbonyl compounds, 1,3-di carbonyl compounds, α,β-unsaturated lactones 1,5-dicarbonyl compounds michael disconnection, use of Mannich Reaction in disconnection, Robinson's annelation.

Synthesis of the following natural products using disconnection approach. Caryophyllene, Pencilline, Cephalosporin, 11-Oxoprogestrone, 11-Hydroxy progesterone, Aphidicaline and Juvabione.

Suggested Books:

1. Carruther, W.*Some Modern Method of Organic Synthesis*. Cambridge University Press, 1986

2. House,H. O. *Modern Synthetic Reactions*W. A. benjamin; 2nd edition, June 1972.

3.Finar, I. L. *Organic Chemistry*, Vol.2. Pearson publisher, 1956.

4. Norman, R.O.C, Coxon, J.M. *Principles of Organic Synthesis* CRC Press, 3rd edition, September 1993.

5. Warren, S. *Organic Synthesis: The disconnection approach* John Wiley, 2nd edition, Cambridge, 2008.

6. Michael C. Pirrung, Synthetic Organic Chemistry, 2nd Edition, Elsevier.

Course Tittle: Molecules of Life

Course Code: CHE614B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Objective of the Course: It is the harmonious and synchronous progress of chemical reactions in body which leads to life. These chemical reactions involve certain molecules called biomolecules or molecules of life. These molecules constitute the source of energy in the body, build the body, act as catalyst in many processes and also responsible for the transfer of characters to off-springs. In this course one would get the information about the structures of these molecules and their role in life related processes. The basic types of molecules included are carbohydrates, proteins, enzymes, lipids and nucleic acids.

Expected Prospective: This course will equip students of interdisciplinary subjects with the necessary chemical knowledge concerning the fundamentals in the basic areas of natural science. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following post graduation in this course.

UNIT I

Carbohydrates **(10 Lectures)**

Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structures.Epimers, mutarotation and anomers.Determination of configuration of Glucose (Fischer proof).Cyclic structure of glucose.Haworth projections.Cyclic structure of fructose. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

UNIT II

Amino Acids, Peptides and Proteins **(20 Lectures)**

Classification of Amino Acids, Zwitter ion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.Determination of Primary structure of Peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–

terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme).Synthesis of simple peptides (upto dipeptides) by N-protection (tbutyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

Enzymes

Introduction, nomenclature and classification of enzymes, Mechanism of enzyme action, Specificity of enzyme action (Including stereo specificity), Enzyme kinetics, Mechaelis-Menten equation, factors affecting enzyme action, Activators and Coenzymes (NAD, FAD and Acetyl coenzyme), cofactors and their role in biological reactions, Isozymes, Enzyme inhibition, role of enzymes in pharmaceuticals.

UNIT III

Nucleic Acids **(15 Lectures)**

Components of Nucleic acids, structure and functions of purines and pyrimidine bases, nucleosides and nucleotides, Base pairing, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Lipids Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils andfats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

UNIT IV

Concept of Energy in Bio systems **(15 Lectures)**

Introduction to Metabolism (catabolism and anabolism), Carbohydrate metabolism (Glycolysis, Krebs cycle and fermentation).Protein metabolism, lipid metabolism, beta oxidation of fatty acids, Inter-relationships in the metabolic pathways of Proteins, Fats and Carbohydrates.Energy production through different metabolic processes (ATP production).Calorific value of food.Standard caloric content of carbohydrates, proteins and fats.

Suggested Books:

1. Morrison, R. T. and Boyd, R. N. *Organic Chemistry*, Pearson Education, 6th edition, 1992.

2. Finar, I. L. *Organic Chemistry* (Volume 1), Pearson Education, 6th edition, 1973.

3. Finar, I. L. Organic Chemistry (Volume 2), Pearson Education, 6th edition, 1973.

4. Nelson, D. L. and Cox, M. M. *Menninger's Principles of Biochemistry,* W. H. Freeman 7th edition, 2004.

5. Berg, J. M., Tymoczko, J. L. and Stryer, L. *Biochemistry*, W. H. Freeman, 6th edition.

6. Russ Hodge, Molecules of Life: DNA, RNA and Proteins.

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Course Name: Nanoscience and Nanotechnology

Course Code: PHY670

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

UNIT I **(15 Lectures)**

Introductory Aspects: Free electron theory and its features, Idea of band structure - metals, insulators and semiconductors. Density of state and its variation with energy, Effect of crystal size on density of states and band gap. Electron confinement in one, two and two-dimensions, Nanostructures and its types, role of size, quantum confinement, surface to volume ratio, Size-dependent properties and applications, Single electron tunneling.

UNIT II **(15 Lectures)**

Preparation of Nanomaterials: Nucleation and growth of nanostructures: Homogenous and heterogeneous, Top down and bottom upapproaches, Chemical route: Chemical precipitation, Sol-gel, Microemulsions or reverse micelles, Solvothermal/hydrothermal, Electrochemical,Self-Assembly Monolayers (SAM), Physical routes - Inert gas condensation, Sputtering, Laser ablation, Ball Milling, Molecular beam epitaxy, Chemical and Molecular vapour deposition methods, Lithography.

UNIT III **(15 Lectures)**

Characterization Techniques: X-ray diffraction (XRD), determination of particle size, study of texture and microstructure, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM) - Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM) Transmission Electron Microscopy (TEM), Optical characterization – UV-Visible, Photoluminescence, Vibrational spectroscopy, Magnetic resonance spectroscopy.

UNIT IV **(15 Lectures)**

Special Nanomaterials: Carbon: nature of carbon bond; new carbon structures; Carbon clusters: small carbon clusters, structure of C_{60}, alkali doped C_{60}; Carbon nanotubes: fabrication, structure, electrical properties, vibrational properties, mechanical properties, application of carbon nanotubes: field emission and shielding, computers, fuel cells, chemical sensors, catalysis, Graphene – fabrication and properties

Reference Books:

1. Chow, G.M. and Gonsalves, K.E., *Nanotechnology - Molecularly Designed Materials*, American Chemical Society (1996).

2. Jain, K.P., Physics of Semiconductor Nanostructures, Narosa (1997).
3. Cao, G., *Nanostructures and Nanomaterials: Synthesis, Properties and Applications,* Imperial College Press (2004).
4. B. D. Cullity, *Elements of X –ray Diffraction,Prentice Hall,*3rd edition (2001).
5. R.F. Egerton, *Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM* F. Egerton, Springer (2005).
6. Nalwa,H.S.*Encyclopedia of Nanotechnology*, Springer (2012).
7. Bhusan, B. *Springer Handbook of Nanotechnology*, Springer, 3rd edition (2010).

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Scheme of Courses M.Sc.

M.Sc. (Hons.)Chemistry

Semester 4

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	CHE609B	Core	Organic Chemistry-IV	4	0	0	4
2	CHE610B	Core	Bio-Inorganic Chemistry	4	0	0	4
3	CHE612B*	Core	Project	0	0	0	6*
4	CHE621B*	Core	Advance Chemistry Lab-II	0	0	8	4*
5	Departmental Elective			4	0	0	4
6	Departmental Elective			4	0	0	4
	Total						20*/22*
Departmental Elective (Choose any Two courses)							
4	CHE611B	Elective	Bio-Physical Chemistry	4	0	0	4
5	CHE613B	Elective	Supramolecular Chemistry	4	0	0	4
6	CHE615B	Elective	Chemistry of Materials	4	0	0	4
7	CHE616B	Elective	Medicinal Chemistry	4	0	0	4
8	CHE618B	Elective	Advance Physical Chemistry	4	0	0	4

L: Lectures T: Tutorial P: Practical Cr: Credits

***The students with research projects will doProject work (CHE612B) of 6 credits and the others will study Advance chemistry Lab-II (CHE621B) of 4 credits in the fourth semester.**

Course Title: Organic Chemistry-IV (Chemistry of Natural Products)

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Code: CHE609B

Total Lectures: 60

Course Objectives:

This course is intended to teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc (2nd Year) in the subject of Chemistry has been framed as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Expected Prospective: This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Organic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Terpenoids and Carotenoids **(12 Lectures)**

General introduction, occurrence, methods of isolation andimportance. Classification and nomenclature. Isoprene rule and Gem-dialkyl rule.Structure determination, stereochemistry and synthesis of the following representative molecules: citral, Terpeneol, Farnesol, santonin, phytol, Abietic Acid and Beta-Carotene, vitamin A.

UNIT II

Alkaloids **(12 Lectures)**

Definition, occurrence, isolation, nomenclature, classification based on nitrogen heterocyclic ring, physiological actionand medicinal importance of alkaloids, general method of structure elucidation, degradation. Structure elucidation and synthesis of the following: Hygrine, Nicotine, Ephedrine, (+)- Conine, Atropine, Quinine and Morphine.

Amino acids, Peptides and Proteins **(8 Lectures)**

Introduction, amino acid classification and structure, general properties of amino acids and methods of synthesis. Classification of proteins, chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Solid phase peptide synthesis. Structure of proteins and forces responsible for holding protein structure.

UNIT III

Steroids **(14 Lectures)**

Occurrence, nomenclature, basic skeleton. Diel's hydrocarbon. Stereochemistry and structure determination of cholesterol. Structure, biological importance and physiological effects of steroids, Vitamin D, Bile acids, Androgens, Oestrogens, Gestogens and Adrenocortical hormones. Synthesis of Cholesterol, Testosterone and Progesterone.

UNIT IV

Vitamins **(14 Lectures)**

Structure, synthesis and biological importance of Vitamin B complex, Vitamin C, Vitamin E and Vitamin K.

Porphyrins

Structure, importance and synthesis of Haemoglobin and chlorophyll

Prostaglandins

Occurrence, classification and physiological effects. Synthesis of PGE2 and PGF 2.

Suggested Books:

1. Finar, I.L. *Organic Chemistry*, ELBS, Vol. 2, 5th edition, 1975.
2. Nogradi, M. *Stereoselective Synthesis: A Practical Approach*, VCH, 1995.
3. Coffey, S. *Rodd's Chemistry of Carbon Compounds,* Elsevier, 2nd Edition.
4. Hostettmann, Kurt, Gupta, M.P. and Marston, A. *Chemistry, Biological and Pharmacological Properties of Medicinal Plants*, Americas, Harwood Academic Publishers.
5. Aggarwal, O.P. *Chemistry of Organic Natural Products*, Vol. 1 & 2, Goel Publishing House, 2009.
6. Rohm, B.A. *Introduction to Flavonoids,* Harwood Academic Publishers, 1998.
7. Rahman, A. and Choudhary, M.I. *New Trends in Natural Product Chemistry,* Harwood Academic Publishers, 1998.
8. Dev, Sukh. *Insecticides of Natural Origin,* Harwood Academic Publishers, 1997.
9. Mann, J. Davidson, R.S., Hobbs, J.B., Banthrope, D.V. and Harborne, J.B. *Natural Products:Chemistry and Biological Significance,* Longman, Essex, 1994.

Course Title: Bio-Inorganic Chemistry

Course Code: CHE 610A

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives: This course is intended to learn the basic concepts of Inorganic Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective: This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Inorganic chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Inorganic Chemistry of Enzymes - I **(18 Lectures)**

Introduction, energy sources for life, non-photosynthetic processes, metalloporphyrins, cytochromes, biochemistry of iron, iron storage and transport, ferritin transferring, bacterial iron transport, hemoglobin and myoglobin, nature of heme-dioxygen binding, model systems, cooperativity in hemoglobin, physiology of myoglobin and hemoglobin, structure and function of hemoglobin. Other iron-porphyrin biomolecules, peroxidases and catalases, cytochrome P450 enzymes, other natural oxygen carriers, hemerythrins, electron transfer.

UNIT II

Inorganic Chemistry of Enzymes - II **(18 Lectures)**

Respiration and photosynthesis (chlorophyll and photosynthetic reaction center); ferridoxins, and subredonim carboxypeptidase, carbonic anhydrase, Blue copper proteins, superoxide dismutase hemocyanines, Enzymes: Structure and function, inhibition and poisoning Vitamin B12 and B12 coenzymes metallothioneins, nitrogen fixation, in-vitro and in-vivo nitrogen fixation, bio-inorganic chemistry of Mo and W, nitrogenases: other elements V, Cr, Ni (essential and trace elements in biological systems).

UNIT III

Metal Ions in Biological Systems **(14 Lectures)**

Biochemistry of dioxygen, bioinorganic chips and biosensors. Biochemistry of calcium as hormonal messenger, muscle contraction blood clotting, neurotransmitter, Metals in the regulation of biochemical events. Transport and storage of metal ions in vivo.Metal complexes as probes of structure and reactivity with metal substitution. Roles of Na^{+}, K^{+}, Mg^{2+}, Ca^{2+} and Ion pumps.

UNIT IV

Inorganic Medicinal Chemistry **(10 Lectures)**

Fundamentals of Toxicity and Detoxification, Nuclear medicines, Chelation Therapy, Cancer Treatment, Anti-arthritis Drugs, Imaging agents

SuggestedBooks:

1. Huheey, J. E., Keiter, E. A. and Keiter, R.L. Inorganic Chemistry Principles of Structure and Reactivity, 4 th edition, Haper Collins.

2. Douglas, B., McDaniel, D. and Alexander, J. Concepts and Models of Inorganic Chemistry, John Wiley and Sons, 3rd edition.

3. Cotton, F.A. and Wilkinson, G. Advanced Inorganic Chemistry: A Comprehensive Text, John Wiley, 5th edition.

4. Elschenbroich, Ch. and Salzer, A. Organometallics. A Concise Introduction, VCH, 2nd edition.

5. Shriver, D.F. and Atkins, P.W. Inorganic Chemistry, Oxford University Press, 3rd edition.

6. Cowan, J.A. Inorganic Biochemistry, Wiley – VCH, 2nd edition.

7. Lippard, S. J. Progress in Inorganic Chemistry, Vols. 18 and 38, Wiley-Interscience, 1991.

8. K. Hussain Reddy, Bioinorganic Chemistry, New age Internation Limited, Publisher, 2007.

Course Title: Advance Chemistry Lab-II

Course Code: CHE621B

Time: 08 Hours

Course Objectives:

To teach the advance techniques in the Chemistry lab. The syllabus pertaining to M.Sc. (Hons.) in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Expected Prospective: The students will be able to understand the advance techniques required to synthesize, analyze different chemical compounds, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals and solvents.

Advance Organic Chemistry Lab

1. Spectroscopic identification of organic compounds and Chromatographic purification:

a. Identification of unknown organic compounds by interpretation of IR, UV, ^{1}H -NMR, ^{13}C NMR and mass spectral data. A minimum of 5 representative examples should be studied.
b. Thin layer chromatography: Determination of purity of a given sample, monitoring the progress of chemical reactions, identification of unknown organic compounds by comparing the R_f values of known standards.
c. Separation by column chromatography: Separation of a mixture using silica gel as adsorbent. Column chromatography should be monitored by TLC.

2. Synthesis of organic molecules & isolation of natural products

(A) Laboratory synthesis of the following compounds:

2-Phenyl indole (Fischer indole synthesis), 7-hydroxy-3-methyl flavone (Baker – Venkatramanreaction), 2,5-Dihydroxy acetophenone (Fries reaction), 4- Chlorotoluene from p-toluidine (Sandmeyer reaction), Benzpinacol (photochemical reaction), 7-hydroxy coumarin

(Pechman synthesis), Pictet-Spengler reaction, Photo-dimerization of maleic anhydride, benzophenone (Friedel-Crafts reaction), Vanillyl alcohol from vanillin ($NaBH_4$ reduction), Acridone from Phthalic anhydride.

(B) Isolation of the following natural products:

Caffeine from tea-leaves (solvent extraction), Eucalyptus oil from leaves (steam distillation), Lycopene from tomatoes.

3. Protection/deprotection strategy of functional groups in organic synthesis:

Protection/deprotection of alcohol and amines in the synthesis of small organic molecules.

Suggested Books:

1. Harwood, L.M. and Moody, C.J. *Experimental Organic Chemistry,* Blackwell Scientific Publishers, 1st edition, 1989.

2. Vogel, A.I. *Text Book of Practical Organic Chemistry*, ELBS, Longman Group Ltd., 5thedition, 1978.

3. Mann, F.G. and Saunders, B.C. *Practical Organic Chemistry*, New Impression, Orient Longman Pvt. Ltd., 4th edition, 1975.

4. Leonard, J. and Lygo, B. *Advanced Practical Organic Chemistry,* Chapman and Hall, 1995.

Course Title: Bio-Physical Chemistry

Course Code: CHE611B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Physical Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the post-graduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Fundamentals of Biological Macromolecules (15 Lectures)

Biological Cell and its Constituents: Biological Cell, structure and functions of proteins, enzymes, DNA and RNA in living systems

Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic, Hydrolysis of ATP, synthesis of ATP from ADP, coupled reactions, degree of coupling.

Biopolymer Interactions: Forces involved in biopolymer interactions, Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions, Multiple equilibria and various types of binding processes in biological systems, Hydrogen ion titration curves.

UNIT II

Thermodynamics of Biopolymer Solutions (10 Lectures)

Biopolymer Solutions Thermodynamics of biopolymer solutions, osmotic pressure, Donnan membrane equilibrium, muscular contraction and energy generation in mechano chemical system.

Cell Membrane and Transport of Ions Structure and functions of cell membrane, Active transport across cell membrane, irreversible thermodynamics treatment of membrane transport.

UNIT III

Structural Determination of Biological Macromolecules (25 Lectures)

Bio-polymers and their Molecular Weights

Evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques.

Viscosity

Measurement, relation to geometry and correlation with hydrodynamic properties.

Diffusion

Fick's Law of diffusion, diffusion coefficient and its interpretation, frictional coefficient.

Ultracentrifugation: Svedberg equation, sedimentation equilibrium, density gradient sedimentation.

Electrophoresis: General principles, Double layer techniques, moving boundary electrophoresis, zonal electrophoresis, isoelectric focusing.

Osmotic Pressure

Second virial coefficient, Determination of Molecular weight of bio polymers

Optical Properties of Biomacromolecules

Light Scattering, fundamental concepts, Rayleigh Scattering, Scattering by Larger particles.

UNIT IV

Methods for the Separation of Biomolecules (10 Lectures)

General principles, including Chromatography; Sedimentation, Moving Boundary Sedimentation, Zonal Sedimentation, Electrophoresis, Isoelectric focusing, Capillary electrophoresis, MALDI-TOF.

Suggested Books:

1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. James P. Allen, Biophysical Chemistry, a John-Willey and Sons Publications.
4. Biochemistry, Voet and Voet, John Wiley.
5. Macromolecules: Structure and Function, F.Wold., Prentice Hall.
6. Text Book of Polymer Science, F.W. Billmeyer.

7. Physical Chemistry of Polymers, A. Tager.
8. Biophysical Chemistry, Vol. 1-3, C. R. Cantor & Schimmel
9. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by D. M. Freifelder
10. Biophysical Chemistry: Principles and Techniques by A. Upadhyay, Himalaya Publishing House.

Course Title: Supramolecular Chemistry
Course Code: CHE613B
Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:
This course is intended to learn the basic concepts of supramolecular chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.

Expected Prospective: This course will equip students with the necessary chemical knowledge concerning the supramolecular chemistry and its applications. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in the course.

UNIT I

Concepts **(17 Lectures)**

Definition and Concepts of supramolecular chemistry.Development of Supramolecular Chemistry. Various types of non-covalent interactions (Hydrogen bonds, π-π interactions, cation-π interactions, Closed shell interactions, solvation and hydrophobic effects, Van der Waals interactions.

Macrocyclic and macro-bicyclic effect, template effect (illustrated by acyclic, macrocyclic and macropolycyclic ligand systems), supramolecular Host-Guest chemistry, Lock and Key Analogy. Binding constant and measurement of binding constant. Cooperativity and chelate effect, molecular and chiral recognition, pre-organization and complementarily, concept of induced fit, allosteric effect.Concept of host design.

UNIT II

Crystal Engineering **(10 Lectures)**

Concept of crystallization and crystal engineering. Supramolecular tectones and synthons, Mechanochemistry and Topochemistry, Graph Set analysis, CSD data base of CCDC.

Polymophism: types and application in pharmaceutical industry. Co-crystal: types and application in pharmaceutical industry.

Crystal Engineering of Pharmaceutical Co-crystals: Introduction, Preparation, Relevance in the Context of APIs, Pharmaceutical Co-crystal, Case Study: Pharmaceutical Co-crystals of Carbamazepine

UNIT III

Supramolecular Host **(18 Lectures)**

Cation Binding

Crown ethers: Discovery, Scope and Synthesis, Conformational Characteristics of Crown Ethers, Donor Group Orientation and Chelate Ring Size Effects, Cation Binding by Crown Ethers, Solution Applications of crown ethers.

Lariat ether, Bibracchial Lariat Ethers, and Podands: Cation Binding by Lariat Ethers.

Cryptands: Discovery, Scope and Synthesis, Cation Binding by Cryptands, Sepulchrates and sarcophagenes

Spherands: Discovery, Scope and Synthesis,

Ditopic Receptors,Chiral Recognition, Amphiphilic Receptors, TheSiderophores

The calixarenesCation Complexation by Calixarenes

Anions Binding

Anions in environment, challenges in designing anion binding host, Guanidinium-based receptors, Neutral receptors, organometallic receptors

Neutral Molecular Binding

Cyclodextrin: Introduction and Properties**,** Preparation, Inclusion Chemistry, Industrial Applications

Molecular Clefts and Tweezers

Cyclophene: General Aspects, Cyclophane Nomenclature, Cyclophane Synthesis

Carcerands and Hemicarcerands: Definitions and Synthesis

UNIT IV

Applications of Supramolecular Chemistry **(15 Lectures)**

Network Solids: What Are Network Solids? Concepts and Classification, Network Topology, Porosity

Inorganic Porous Materials: Zeolites - Composition and Structure, Synthesis, MFI Zeolites in the Petroleum Industry

Inorganic-Organic Hybrid materials: Coordination Polymers, Metal Organic Frameworks and Other Terminology, 0D Coordination Clusters, 1D, 2D and 3D Structures. Interpenetrated Structures, Catalysis by MOFs, Hydrogen Storage by MOFs

Catenanes and Rotaxanes: Overview, Statistical Approaches to Catenanes and Rotaxanes, Molecular Necklaces

Molecular Knots: The Topology of Knots, Trefoil Knots, Borromean Rings

Molecular Devices

Molecule-Based Electronics: Molecular Electronic Devices, Molecular Wires, Molecular Switches

Liquid Crystals: Nature and Structure, Design of Liquid Crystalline Materials, Supramolecular Liquid Crystals

Supramolecular Gels: concept, types, properties, and applications

Reference

1. Steed, J. W. and Atwood, J. L. *Supramolecular Chemistry*, Wiley: Chichester, 2000.
2. Ariga, K. and Kunitake, T. *Supramolecular Chemistry: Fundamentals and Applications*, Springer, Berlin, 2005.
3. Steed, J. W., Turner, D. R. and Wallace, K. J. *Core Concepts in Supramolecular Chemistyand Nanochemistry*, Chichester, Wiley, 2007.
4. *Frontiers in Crystal Engineering by E.R.T. Tiekink, J.J. Vittal*

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Course Title: Chemistry of Materials

Course Code: CHE615B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of material science. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the students.

Expected Prospective: This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Industrial chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Solid State Chemistry **(15 Lectures)**

Types of solids, band and bond theories, crystal lattice energy, point defects in metals and ionic compounds, energy and entropy of defects, their concentration, diffusion and electrical conduction via defects, non-stoichiometry types, colour centres and electrical properties of alkali halides, electron theories for metal conduction in metals , in insulators, impurity semi-conductors, reactions in organic solids, photochemical reactions, solid-solid reactions, decomposition and dehydration reaction.

UNIT II

Macromolecules **(15 Lectures)**

Types of polymers, regular and irregular polymers, synthesis of polymers by chain and step reactions, physical properties of solid polymers(crystallinity, plasticity and elasticity), vulcanization of rubbers, molecular mass determination by osmometry, viscometer, light scattering and ultracentrifuge methods, number and mass average molecular masses, polymer solutions, factors affecting the solubility of polymers , conducting polymers, doping of polymers, mechanism of conduction, polarones and bipolarons.

UNIT III

Glasses and Ceramics **(15 Lectures)**

Factors affecting glass formation, oxide glasses, electronegativity and bond type, viscosity, structural effects (zachariasen's rule (1932), criteria of SUN and Rawson, thermodynamics of glass formation, behavior of liquids on cooling, kinetics of crystallization and glass formation, structure of glasses: vitreous silica, silicate glasses, vitreous B_2O_3 and borate glasses, viscosity, electrical conductivity of glasses and the mixed alkali effect, commercial silicate and borate glasses, metallic glasses , glass ceramics, refractories, important glass-ceramics compositions, properties of glass ceramics, applications.

UNIT IV

Smart Materials **(15 Lectures)**

Methods of preparation- conventional ceramic methods, hot pressing and hot static pressing techniques, precursor method, gel method, co-precipitation method, glass crystallization methods, vacuum techniques- chemical vapor deposition method, organic superconductors, magnetism in organic materials, magnetic nanomaterials, energy storage materials, nanomaterials for targeted drug delivery, fullerenes as superconductors. High temperature ceramic superconductors, electrical and magnetic properties of superconductors, critical temperature Tc, thermodynamics of superconductors, London equation, BCS theory, applications.

Suggested Books:

1. Cornell,P. J. Flory.*Principles of polymer chemistry*, University Press.
2. Tager,A. J.*Physical chemistry of polymers*, Mir Publishers.
3. Dekker,A. J.*Solid state physics*, MacMillan Publishers.
4. West,A. R.*Solid state chemistry and its applications,* Wiley Publishers.
5. Byrn,S. R.*Solid state chemistry of drugs,* Academic Press.
6. Puri, Sharma and Pathania, *Principles of physical chemistry*, Vishal Publishers.
7. Gray,G. W.*Thermotropic Liquid crystals,* John Wiley.
8. Malcolm, P and Stevens, *Polymer Chemistry,* Oxford University Press.
9. Keer, H. V. *Principles of Solid States*, Wiley Eastern.

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Course Title: Medicinal Chemistry

Course Code: CHE616B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn the basic concepts of Medicinal Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic interest.

Expected Prospective: This course will equip students with the necessary medicinal chemistry knowledge concerning the fundamentals in the basic areas of pharmaceutical sciences The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I

Enzymes (15 Lectures)

Basic considerations. Proximity effects and molecular adaptation. Introduction and historical prospective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer’s lock and key and koshland’s induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-menten and lineweaver-Burk plots, reversible and irreversible inhibition.

Mechanism of Enzyme Action (5 Lectures)

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonucleases, lysozyme and carboxypeptidase A.

UNIT II

Kinds of Reaction Catalysed by Enzymes (10 Lectures)

Nucleophilic displacement on a phosphorus atom, multiple displacement reaction and the coupling of ATP cleavage to endergonic processes. Transfer of sulphates, addition and elimination

reactions, enolic intermediates in isomerization reactions, β-cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

UNIT III

Co-Enzyme Chemistry **(10 Lectures)**

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, LIPOIC ACID, vitamin B12. Mechanisms of reactions catalysed by the above cofactors.

UNIT IV

Drug Design **(20 Lectures)**

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAP), factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptors interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials. LD-50, ED-50 (Mathematical equations excluded)

Suggested Books:

1. Lehninger, *Principles of Biochemistry*,WH-Freeman, 5th edition.

2.Silverman, R. B. *The organic chemistry of drug design and drug action,* Academic press 2nd edition, 2004.

3. PandeyaS. S. and Dimmock,J.R. *An introduction to drug design*, New Age International.

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CourseTitle: Advanced Physical Chemistry

Course Code: CHE618B

Total Lectures: 60

L	T	P	Credits	Marks	Pass Marks
4	0	0	4	100	40

Course Objectives:

This course is intended to learn advancedphysical chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the postgraduate students.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the advances in physical chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers following postgraduation in this course.

UNIT I **(12 Lectures)**

Surfactant Aggregation

Micelles, Surface active agents, Classification of surface active agents, Micellization,Hydrophobic interaction, Critical micellar concentration (cmc), Factors affecting theconcentration of surfactants, Counter-ion binding of micelle, Thermodynamics ofmicellization, Phase separation and Mass action models, Solubilization Emulsions,Mechanism of formation of microemulsion and their stability, Phase maps, Physicaltechniques, Applications.

UNIT II **(18 Lectures)**

Introduction

Macromolecular concept. Molar mass averages, distribution of molecular mass.

Kinetics of Polymerizaton

Kinetics of step growth polymerization, size distribution in linear polymers. Kinetics offree radical addition polymerization, distribution of molar masses, effect of temperature.Ionic polymerization, kinetics of cationic and anionic polymerization.

Statistics of Linear Polymer Chains

Polymer chain flexibility and internal rotation, random flight analysis of end-to enddistance for freely jointed chain in one dimension and three dimensions. Effect of bondangle and restricted

rotation on chain dimensions. Unperturbed chains. Long-rangeinteractions and effect of solvent. Distribution of chain segments relative to centre ofmass.

UNIT III **(15 Lectures)**

Thermodynamics of Macromolecular Solutions

Flory-Huggins theory. Flory-Krigbaum theory of dilute solutions, partial molarquantities.Osmotic pressure.

Characterization of Macromolecules

Flow properties, generalized flow equation. Frictional co-efficient and flow properties.Determination of molecular size and mass from diffusion, sedimentation velocity,sedimetation equilibrium and viscosity. Light scattering and small angle X-ray scattering.

UNIT IV **(15 Lectures)**

Nanomaterials:

Definition, historical perspective and effects of nanoscience and nanotechnology onvarious fields. Synthesis of nanoparticles by chemical routes and characterizationtechniques: Thermodynamics and kinetics of nucleation; Growth of polyhedral particlesby surface reaction, Ostwald ripening, size distribution; TEM; SEM; AFM; Lightscattering; XPS. Properties of nanostructured materials: Optical properties; magneticproperties; chemical properties. Overview of applied chemistry of Nanomaterials.

Suggested Books

1. Young R.J. and Lovell P.A., *Introduction to Polymers*, Pubs: Chapman and Hall,London, 2nd ed., New Delhi (2004).

2. Billmeyer F.W. Jr., *Text book of polymers science*, Pubs: Wiley-Interscience, 3rd edn.,(1984).

3. Myers D., *Surfactant Science and Technology*, Pubs: VCH Publishers (1988).

4. Flory P.J., *Principles of polymer chemistry*, Pubs: Cornell Univ. Press, Ithace (IndianPrint 2006).

5. Tager A, *Physical Chemistry of polymers*, Pubs: Mir Publishers, Moscow (1971).

6. R.J., *Foundations of Colloid Science*, Vols. I & II, Pubs: Oxford Science Publications(1989).

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Interdisciplinary Courses:

S.No	Paper Code	Course Title	L	T	P	Cr
1	CSA555	Fundamentals of Computer and Programming in C/C++	3	0	0	3
	CSA556	Fundamentals of Computer and Programming in C/C++ Lab	0	0	2	1
2	EVS051	Dynamics of Biogeography	4	0	0	4
3	EVS052	Green Technology	4	0	0	4
4	EVS053	Environmental Toxicology	4	0	0	4
5	BOT505	Forestry	4	0	0	4
6	BOT535	Conservation of Natural Resources	4	0	0	4
7	ENG531	Writing Skills	4	0	0	4
8	ENG532	Creative Writing	4	0	0	4
9	ENG533	Living Literature	4	0	0	4
10	MIC006	Fermentation Microbiology	4	0	0	4
11	MIC007	Microbiology of Diseases	4	0	0	4
12	MGT051	Business Strategy	4	0	0	4
13	MGT052	Principles of Marketing	4	0	0	4
14	MGT053	Research Methodology	4	0	0	4
15	CHE615B	Chemistry of Materials	4	0	0	4
16	CHE616B	Medicinal Chemistry	4	0	0	4

17	**MTH 636**	**Discrete Mathematics**	**4**	**0**	**0**	**4**
18	**MTH 633**	**Operational Research**	**4**	**0**	**0**	**4**
19	**MTH560**	**Mathematics for Chemists**	**4**	**0**	**0**	**4**
20	**ZOO701**	**Biology for Chemists**	**4**	**0**	**0**	**4**